Multidisciplinary Design Under Uncertainty for Entry Vehicles, Phase II

Completed Technology Project (2005 - 2007)

Project Introduction

The physical difficulty of designing entry vehicles originates from the large degree of coupling between the various disciplines involved in the design. Every subsystem design decision has far reaching consequences that must be evaluated in a multidisciplinary fashion in order to assess the impact on the weight and the performance of the entire vehicle. The disciplines which must be accounted and integrated during the design are: trajectory optimization, guidance, navigation, and control (GN&C) technology, aerodynamics and aerothermodynamics, thermal-structural analysis, and thermal protection system (TPS) development. Previous efforts in developing a collaborative or a multidisciplinary optimization process never considered how uncertainty in the atmospheric conditions, in the entry parameters of the vehicle, in the condition of the vehicle during entry, and in the performance of the TPS will influence the design and provide a risk assessment for a mission. The work completed during the Phase I effort demonstrated that it is feasible to develop a tool for multidisciplinary optimization under uncertainty (MDO-U) for entry vehicle design, and the new information which is gained is insightful and meaningful. The functionality and the value of the new MDO-U design tool were demonstrated through a case study where MDO-U was performed for the HL-20 vehicle under a LEO consideration. During Phase II a general purpose and user friendly MDO-U product which can be used in entry vehicle design, and in many other engineering areas will be developed.

Anticipated Benefits

Potential NASA Commercial Applications: Uncertainties due to manufacturing tolerances, material variability, the operating environment, and the state of the operating product, are encountered in the automotive, the shipbuilding, the heavy construction equipment, the defense industries (missile development, ground combat vehicle design), and bioengineering. The MDO-U system will allow engineers to account for uncertainties during the design of their products while considering the cross-coupling among the multiple disciplines involved in each product design. Thus, there is a great market potential for the outcome of this SBIR. For the general purpose MDO-U product (without the entry vehicle specific capabilities), the proposing firm will have Noesis Solutions (an established internationally firm in optimization products) as a commercialization partner.

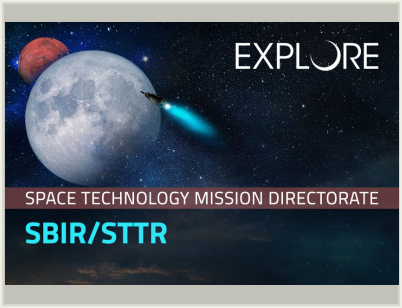

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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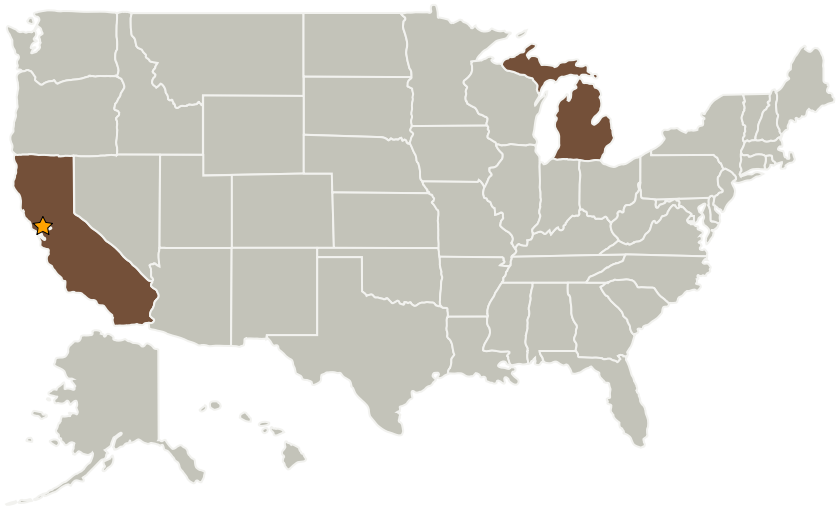
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Michigan Engineering Services, LLC	Supporting Organization	Industry Women-Owned Small Business (WOSB)	Ann Arbor, Michigan

Primary U.S. Work Locations	
California	Michigan

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Nickolas N Vlahopoulos

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.1 Aeroassist and Atmospheric Entry
    - TX09.1.2 Hypersonic Decelerators